DOCUMENT RESUME

ED 319 383 IR 014 401

TITLE Images of Potential Report of a Working Conference of the Learning Tomorrow Project (Racine, Wisconsin, January 1989) .
INSTITUTION National Foundation for the Improvement of Education, Washington, D.C.
PUB DATE 89
NOTE 41p.
PUB TYPE Collected Works - Conference Proceedings (021) -- Viewpoints (120) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Educational Technology; Elementary Secondary Education; Employment Qualifications; Facility Planning; Futures (of Society); *Labor Needs; *Long Range Planning; Rural Schools; *Social Support Groups; *Urban Schools
IDENTIFIERS *Learning Tomorrow Project; *Scenario Writing

ABSTRACT

In order to catalyze the exploration, planning, and implementation of successful technology integration into schools, the National Foundation for the Improvement of Education (NFIE) hosted Stage I of the national initiative, Learning Tomorrow, in January 1989. Thirty-eight professionals, including classroom teachers, school facilities designers, hardware and software producers, and futures researchers, convened in Racine, Wisconsin, for a 2-day working conference in which they developed scenarios of the learning environment with technology utilized to support education. Working in six teams, the participants produced scenarios distinguished by stage of student development and geographic context. The six scenarios included in this report describe learning environments in a rural elementary school, middle school, and high school, and in an urban (or suburban) elementary school, middle school, and high school. Among the issues discussed by the groups and addressed in the scenarios are the availability of family and social support structures, the nature of communities, the types of social and intellectual skills that students will require to be successful as adults, and the projected needs of the workforce. Appended is a glossary of terms used in the report. (GL)

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IMAGES OF POTENTIAL

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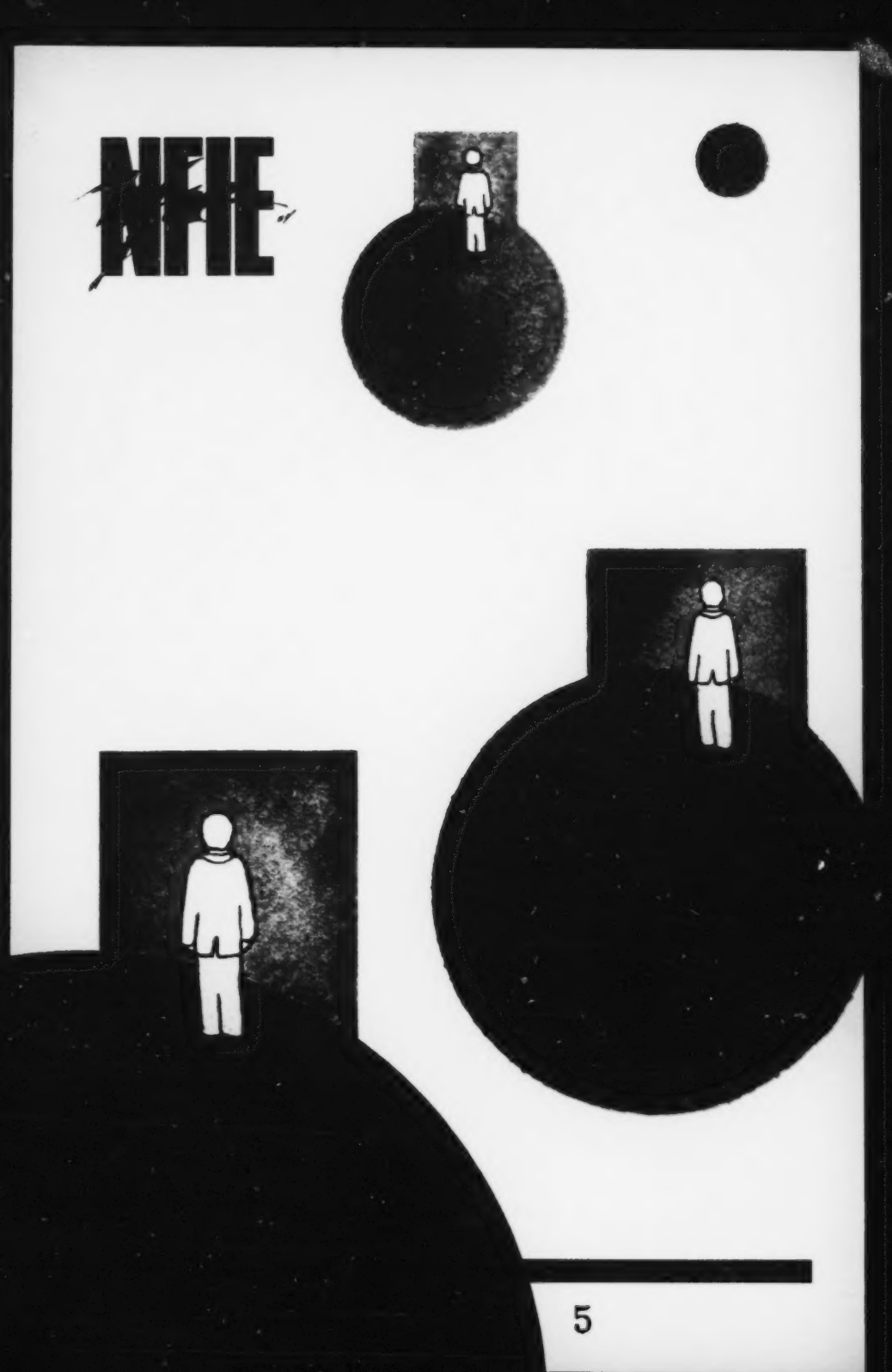


Learning Tomorrow is a national initiative which supports and stimulates the use of technology in restructured schools. While information technologies have transformed most sectors of society, much of the educational sector lags behind. The applicability of these technologies to education has long been accepted as a concept, but moving ideas into practice has always been a struggle. School restructuring is viable only when and if we rededicate ourselves to preparing all students to lead happy and productive lives.

Creative, risk-taking teachers committed to this goal already are experimenting in their own classrooms with innovative uses of technologies. The National Foundation for the Improvement of Education has created *Learning Tomorrow* to expand the knowledge and efforts of a few to the entire nation and, with the help of technology, effect lasting educational change to meet the needs of all students.

Learning Tomorrow is a five-stage program:

I. Scenario-building
II. Call for Innovation in Practice
III. Dissemination and Demonstration
IV. Grants Program
V. Dissemination and Demonstration of Grant Results

This publication is a product of Stage I.

The Concern

Educational reform has become a national priority. While improvements have been made in pockets around the country, the problems of high dropout rates, functional illiteracy, and wide gaps in achievement levels among subgroups of students persist.

There are indications that current crises in education will accelerate in the twenty-first century unless we take action now. Demographers predict that the number of minorities in schools will increase and traditional family structures will continue to erode. Students who are black or Hispanic, or who come from poor or single-parent families consistently have performed worse in school than others. The average reading proficiency of black and Hispanic 17-year-old students is roughly at the seventh grade level.

Moreover, 25 percent—nearly one million—of the nation's youth dropout of school each year. The numbers reach as high as 50 percent in some inner cities. These dropouts are drawn disproportionately from the ranks of lower-income and minority children.

These achievement gaps are not new, but they are more urgent because the percentage of students who are at risk—predominantly poor and minority children—represent an increasing share of both the school population and our future workforce. In the coming decade, 80 percent of new entrants in the workforce will be women, immigrants, or minorities. These groups traditionally have been disadvantaged by discrimination, language limitations, poverty and other economic factors, so they face a particularly arduous task when they enter the job market. One in four members of the class of 2000, now entering first grade, is living in poverty. American society cannot afford to write off this segment of the population.

Exacerbating this crisis are the changing needs of the work place. As we move from an industrial-based to an information-driven economy, employers will demand more highly-skilled workers, with over 90 percent of all jobs requiring some retrieval, assessment, and distribution of information. High school dropouts who once could learn unskilled or semi-skilled jobs will find that those jobs no longer exist in the twenty-first century.

The United States continues to lead the world in new job creation. In the last two decades, we have generated about 35 million new types of jobs, and experts predict that we will generate between 12 and 15 million addi-

tional jobs before the turn of the century. This sounds encouraging until one considers that 75 to 85 percent of these new jobs require cognitive, not manual, skills as well as post-secondary education.

The Potential

The National Foundation for the Improvement of Education believes that technology is a tool whose potential to improve teaching and learning has yet to be discovered fully. Like a piece of chalk or a textbook, technology can be a vital component in classroom teaching. Technology can enable learners to move from low-level tasks to ones more cognitively demanding, and to better understand the curriculum through exploration, manipulation, and guided discovery. It can help teachers reach students they currently find difficult to reach.

Technology allows teachers to create their own teaching materials, delivery systems, and assessment techniques. By facilitating quick and effective management and administration in the classroom, e.g. scheduling and grading papers, technology can free teachers to spend more time interacting personally with students. Technology challenges us, now more than ever, to be innovative and deliberate in planning to maximize the productivity of teachers' time with their students.

Consistent with its mission, NFIE has undertaken a national initiative to explore, stimulate, and support the use of technology in America's public schools. This publication represents the first of five stages in this multi-year effort entitled *Learning Tomorrow*.

The Context

The Technology

According to reports from the National Governors' Association and the U.S. Congress, America's schools were inundated with advanced technology of all types during the 1980's. For example, in 1980 very few schools had videocasette recorders (VCRs). By 1988, roughly 90 percent had them. Cable and satellite transmission have increased the flexibility of television use, including remote delivery of instruction. The 1980's saw the introduction of computers, laserdiscs, videodiscs and a wide array of other emerging technologies as accessible, viable classroom tools.

While we know that many technologies have great potential to impact learning, the most common form of technology used in today's schools is the computer.

Between 1981 and 1987, the percentage of schools with one or more computers intended for instruction grew from about 18 percent to 95 percent.

Yet, despite this influx of computers, schools still do not have enough of them and teachers do not receive adequate training to render the computer a central element of instruction. There is about one computer to every 30 students in today's schools. Not all students use these computers. Those who do use them spend on average a little more than one hour per week, about four percent of their instructional time, on the computer. This low rate of use is understandable when we consider that only 1/3 of all K-12 teachers report having had as much as 10 hours of computer training. Most of those hours have focused on learning about computers rather than how to teach with them. Consequently, only that same number report ever having used the computer in instruction.

At the same time, almost all teachers (94 percent) agree that students need more help and support than they have needed in the past. Forty percent of teachers report "teaching" less than 75 percent of the time. NFIE believes that technology is one of the vehicles through which teachers can make their time and efforts with students more effective.

The educational field lacks the in-depth exploration, let alone the empirical evidence, to prescribe how technology should be used. However, we do know that technology supports a variety of learning styles, contexts, and curricula. It has the potential to expand teaching and learning beyond the four walls of the classroom. We know technology suggests multiple teaching/learning patterns, challenging educators to pursue creative alternatives to the traditional lecture/worksheet regimen.

While we can tally the merits of technology, educators generally agree that there are limitations as well. Technology should not be used to drive educational goals, but rather to achieve them. And we know technology should be viewed as a tool to support learning rather than as a good thing in and of itself. Technology does not answer all of our problems, but it can play an important part.

The Process

In order to catalyze the exploration, planning, and implementation of successful practice, NFIE hosted Stage

I of Learning Tomorrow in January 1989. Thirty eight professionals representing classroom teachers, school facilities and design, corporations, hardware and software producers, school improvement and restructuring, and futures research convened at the Wingspread Conference Center in Racine, Wisconsin for a two day working conference. Their charge: to develop scenarios, or images, of the learning environment with technology utilized to support education.

The participants worked in six teams to produce scenarios distinguished by stage of student development and geographic context. Thus, the following six scenarios describe learning environments in:

Rural Elementary School
Urban/Suburban Elementary School
Rural Middle School
Urban/Suburban Middle School
Rural High School
Urban/Suburban High School

The participants sketched the scenarios through an iterative process of sharing expertise, backgrounds, and ideas for restructuring schools. Despite the vast diversity of perspectives, all of the groups focused on the same target: the student.

The Context

They looked at the projected characteristics of students who would be entering schools in the 21st century. The groups discussed the family and social structures that would or would not be there to support them, the nature of communities, the types of social and intellectual skills students would require to be successful as adults, the needs of the workforce, etc.

In developing their scenarios, the participants were asked to put aside traditional constraints on schools such as finances, bureaucratic structures, and nostalgic adherence to convention and to concentrate on what could be done if society made a commitment to improve education.

During the two days, the entire group of thirty eight met only twice. The six groups, therefore, worked in relative isolation. One might think that, given the infinite domain of strategies for teaching children, six such groups would conjure up contrasting or even conflicting visions of tomorrow's schools. Quite the contrary! It is encouraging, and perhaps comforting, that the resulting six scenarios portray the same holistic, human-centered approach to education. They reflect similar visions, goals, and sensitivities toward tomorrow's schools.

The Images

Each scenario should be viewed as a snapshot, taken at one point in time, rather than as a videotape or motion picture. Like snapshots, the scenarios are taken from a variety of perspectives. The groups chose varied lenses, angles, depth of field, and numbers of subjects to photograph. Unlike motion pictures, these scenarios do not describe the progression, how the figures in the photograph got there or where they are going next.

The scenarios pack an incredible number of activities, influences, and other stimuli into a given school day. The reader may feel exhausted by 9:00 a.m. in the learner's day and wonder how anyone could realistically survive, let alone succeed, with such a hectic schedule. The authors did not intend for each day to be so intensive; they sought to capture the essence of the learning experience by describing a wide array of potential practices for teaching and learning.

Like snapshots, the scenarios do not always consider the problems encountered or the multiple contexts in which the learning takes place. They don't, for example, explore the role of the administration, the future of textbooks, or the impact of state or local mandates. One might conjecture where the scenario could fall on a map, but—aside from rural or urban/suburban—the scenarios are independent of geographic region.

Some elements of the scenarios describe existing practice. They may be innovative and new, or mainstream, traditional strategies. The innovation is not always technological. The authors emphasized practices that facilitate learning and the development of the learner. The scenarios are not, in fact, that far from reality.

The Common Themes

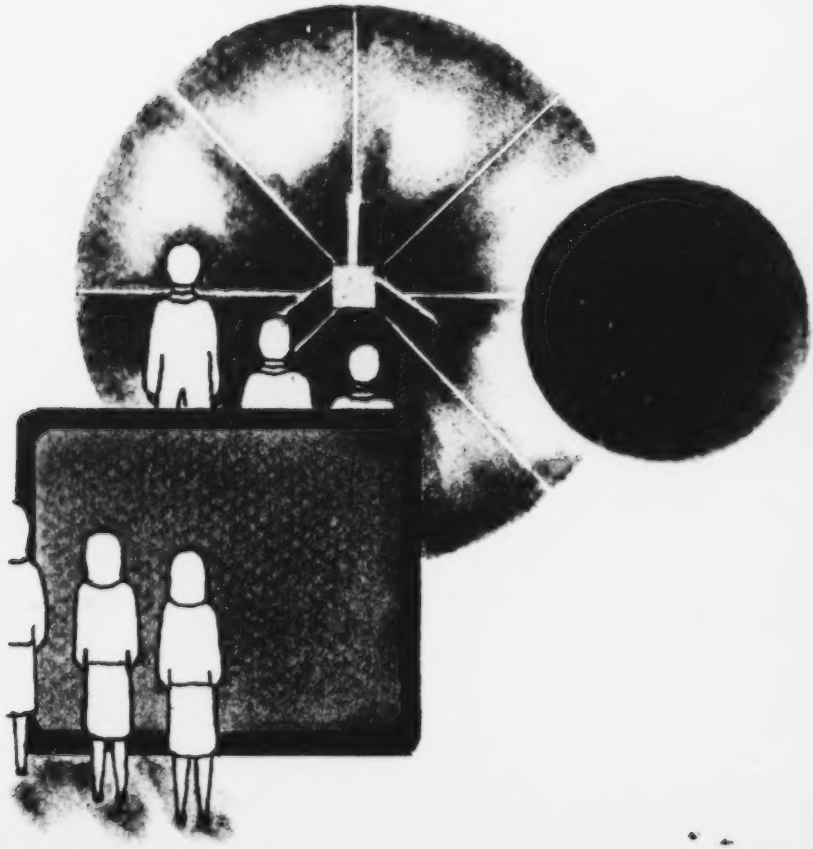
These six scenarios are instructive, not only because they provide alternative images of the future, but also because they illustrate a set of underlying elements or themes that appear to run throughout any image of the future. Collectively, the scenarios reflect:

- a central focus on students' characteristics and individual learning styles, e.g. self-directed, integrated, collaborative, and distance learning, etc., rather than on the machinery of technology
- a concern that technology serve all learners, including "at-risk" and disabled to reduce the gap between the

information-rich and information-poor

- students applying their knowledge in purposeful activities, e.g. providing assistance to the community, working with other students on global issues, rendering relevance, practicality, and societal value to their education
- learning environments which extend beyond the walls of the school, often involving community members and others not traditionally associated with student learning
- inter-disciplinary approaches to curriculum often involving some form of teaming of teachers from different subject areas
- high teacher expectations and belief that students are capable of solving complex problems
- a belief in the importance of utilizing existing and emerging technologies and researching their full potential for supporting education
- increased students' responsibility for their own learning and the learning of others
- the application of a mixture of technologies which extends beyond the classroom computer
- a balance of technology-facilitated and human-facilitated learning
- flexible use of facilities, time, and human resources
- sensitivity to the development, health, and well-being of the whole learner rather than limited to academic development

The scenarios are images of potential. Creative, risk-taking teachers in pockets across the country are realizing some of that potential today. It is our hope that these images will stimulate more teachers to employ technology as a tool in their teaching. Educators may choose to take pieces of these scenarios and put them together in different ways, using still different scopes and angles to produce more new and creative scenarios for tomorrow's schools.



Rural Elementary School

It is the turn of the twenty-first century and Ms. Harrison is returning to her home town where she has just signed her first year teaching contract. Ms. Harrison is the pride of the community, since she is one of the local American Indians who went to college and is serious about sharing the benefits she has gained from her educational opportunities.

She remembers fifth grade, because that was the year she decided to become a teacher. Her grandparents lived on the reservation, but Suzy, as they called her then, lived with her parents in town. Her father worked in the oil field and her mother as a clerk in one of the local stores. Both of her parents valued her in-school education, but were concerned that she was not developing an understanding of her cultural heritage. Her grandmother shared this concern.

The school's technology aided her in developing an oral history of her family's tribe. The school's resources included a computer lab with a modest number of computers, as well as a satellite dish, VCRs, overhead projectors, and a library. Suzy checked out a tape recorder and instamatic camera to record the data she gathered from her grandmother and other older women in the tribe.

After organizing and entering the data, Suzy used desk-top publishing to capture the written snapshot she wanted to portray of her people. She remembers beaming proudly at the sight of her oral history published in the town newspaper.

That year Suzy became an avid user of the library and media center of the school. She explored a valuable series of videotapes on Native Americans. She used the videodisc player and especially loved the Vincent Van Gogh art disc. She must have checked it out 100 times that year, each time finding something new about the artist or his work.

Another lasting highlight that year were her computer pen pals. Her teacher had contacted a school in an Eskimo village in Alaska and she continues to write to her pen pal to this day. She was particularly interested in the similarities between Native Alaskan and American Indian family structures.

Now, having completed a Master's program in early education community services, Ms. Harrison is back home. As part of her program, she served as an intern with a group that developed an oral history of a local

community which was aired on the state's PBS network.

The school, or Learning Center, offers a wide range of technologies including individual learning stations, small group learning environments, and moderate to large group learning spaces. The latter include large screen displays and apparatus to feed to other systems via statewide regional media centers.

The town has changed since her youth. The area's economic viability has been threatened. Water problems, falling oil prices, declining population, and pollution have complicated local problems.

The community has been selected by the state as a rural renewal site. The state considers it a good candidate for revitalization due in part to a successful distance learning project from the State University. The community has an ethnically diverse population that always has been committed to the schools and education. Fiber optics have replaced the region's telephone system. The state supports an Integrated Service Digital Network which provides learning technology resources to education, health and social services.

The State Rural Renewal Project requires that new teachers serve on the Community Task Force, whose members vary in age and expertise. Ms. Harrison's role is to ensure that elementary skills learners are involved in community data collection on multiple issues through the use of oral histories.

As part of the general renewal project, the School District will provide Ms. Harrison with an elaborate mentor and support system. In addition to personal sessions with experienced, professional mentors, Ms. Harrison utilizes a wide range of electronic communication resources. These include teachers connected electronically to other school systems, a university-sponsored mentor program, and a distance learning program for professional development. In addition, Ms. Harrison will be free one day each week to attend regional and national meetings with other professional educators.

The community supports the goal that all children be entitled to equity and excellence in education across all subject areas. To meet this goal, the School District has instituted Support Groups which facilitate a personal learner's program (PLP) for every learner. These groups are comprised of the learner's parent or family representative, a community person, social service personnel, and educational professionals to provide for the management of the learner's progress. Each Support Group makes an agreement to work together for the educational progress

of the learner over several years.

Assessment and evaluation of student achievement is based upon competency-based criteria related to the objective worked out in the PLP. Multimedia-based tools are used to assess learner progress. Upon completion of school, learners will have portfolios of their work in writing, science, and other content areas.

This community-based learning system provides services for K-12 and life-long learning programs. A flexible computer scheduling system manages the learning experiences based on the needs of the learner.

The home and parent often are mentioned as the child's first teacher. Radio, television, churches, scout groups, business, and the total community are the proving grounds for learning experiences. It is the educator's responsibility to coordinate these arenas into the mosaic of learning.

Technology is a continuous ribbon of communication resources. The ribbon provides a wide range of content through which the teacher and learner manage individual learning programs to demonstrate the learner's achievements.

Ms. Harrison teaches a diverse group of elementary skill learners. Mary is 68 years old and wants to learn to read and write so she can communicate better with her seven grandchildren. Juan is a 12-year-old boy with limited English speaking abilities. Thomas, the son of migrant workers, is 23 years old and seeking skills to enter the job market. Anita, 32, needs bookkeeping and other business skills to manage her laundromat.

The Scenarios

Urban/Suburban Elementary School

Billy is the younger of two sons of a single, working professional woman. His mother is excited about his educational opportunities and comforted by the support services he will receive for his speech impediment.

Billy's community is well known for its commitment to a "learning for life" philosophy which emphasizes the importance of the individual's fulfillment from the life experience itself and reduces the importance of success based upon status and employment position.

His bedroom computer, which Mom pre-programmed the night before, wakes him and his dog Spot jumps on his bed to get him up. He scans the visual display, which summarizes daily events scheduled at school and in the community. Billy checks on the today's school lunch, the weather, and his "electronic field trip" this afternoon.

Billy's computer also reminds him about his 4:30 meeting with the community speech tutor and the Junior High School Band's evening concert. A flashing light on the computer alerts Billy that his school bus will be late because of bad weather.

Since moving into their new home, each family member has new responsibilities. Billy's include programming the energy efficient thermostat which lowers the room temperatures when not occupied and even monitors humidity for proper plant growth. The home air filtration system maintains a clean internal environment and protects his family and pets from illness which may occur from smog, auto emissions, and acid rain. One of Billy's chores is to remind his mom and brother to do their weekly physical health appraisal which includes a body scan which identifies vitamin deficiencies, stress, and other metabolic processes. As a result of detailed documentation of the aging process and the impact of nutrition, the family maintains a life-long data log.

He walks to the local bus stop. Today he is looking forward to watching a video produced by his international video pal in Uruguay. Tommy, his older friend, is on board already with his laptop computer. He is finishing his English assignment which he will send to his teacher via electronic mail. Other students are talking, singing, and playing electronic games with friends.

Unfortunately, every student in the community does not have a computer. To remedy that situation, a local civic group in cooperation with industry installed several permanent computers, usable by all grade levels, on the school bus.

Billy likes his new school. He was a fourth-grader at his last school. Here, he is part of the red team which spans an 18 month age group. The wider age groupings expose Billy to a broader emotional and psychological developmental experience.

His teacher starts class with a short video on a discussion topic. Students then develop discussion points to develop "a thought for the day." Yesterday, music was the introductory topic. The class discussed moods and emotions and emphasized listening skills, the arts, and aesthetics.

Billy's school is part of a planned community. Because of this cooperative planning, a ten-acre park site set aside for non-recreational activities, is part of the school campus and curriculum. Each of Billy's instructional activities is related to the park area.

Class continues with a review of the events over the

past week. His teacher shows an instructional video of the park site explaining a plant life analysis project. The class has been measuring two species of trees planted five years ago. One grew substantially while the other was stunted. The teacher, through a projection CD Rom capability, reviews the growing process for these specific trees and illustrates how their growth is typical for this region of the country. She also presents other growth profiles which, using simple system modeling, shows how climate, air quality, and rainfall interact to affect plant life.

The withering tree interests Billy because his team has been assigned to investigate this phenomenon. His team, which includes older students, will research the "greenhouse effect" through the media center, CD ROM storage, and a local chemical firm. Since this topic has been in the news lately, several local experts have volunteered to discuss this topic. Also, with their teacher aide's assistance, Billy's team will conduct a conference call with a representative from an international corporation examining this issue in northern Canada.

Billy's team also checked the distance learning curriculum within the county system and found a course on this subject in several district schools. Using the in-classroom fiber optic two-way video network, they will be monitoring this course and asking the older students questions.

The team submits a weekly progress report on this project to their teacher. The report not only records the progress of the group's project, but also is electronically monitored for reading and writing skills and various achievement levels. This information is evaluated electronically and given to his teacher with a copy for his mother as needed.

The Scenarios

Billy has recorded musical sounds to write a song expressing his feelings about the withering tree. While humming melodies about these feelings, Billy suddenly remembers his schedule for the day and realizes he may be late for his "electronic field trip."

He returns to his home classroom where he and his classmates sit in front of the large video projection screen. They can choose between several field trips including a hike in the Grand Canyon, a discussion with NASA astronauts at the Air and Space Museum in Washington DC, or a "walk" through an African village. After a popular vote, which the teacher tabulates electronically, the African village "walk" wins.

Through two way interactive communications, stu-

dents see and speak with African children. Computerized synthetic voice translation creates a person-to-person exchange between French-speaking African students and Billy's class. Two of Billy's classmates fluent in French lead the discussion.

At the end of his day, Billy summarizes his day in his electronic journal and mails it to his teacher. This allows a period for reflection, stimulates creative writing, and is periodically reviewed by his teacher. She can respond with short personal comments about his thoughts and ideas.

Next, he meets with three other students and a special tutor at a satellite center for speech therapy. His services include digital voice analysis and auditory drill to be conducted with a computer simulator. Because of the time freed by technology, the tutor can focus on Billy's psychological and emotional needs.

Billy goes home after a long day and touches the scanner device at the door. A red light signals the house is safe to enter. He knows his school day is over as he sends his daily log to his teacher.

Rural Middle School

Kim's home town suffers from high unemployment. The local middle school serves grades six, seven, and eight and 95% of the students are bussed. Students are assigned to a Teaching/Learning Corps (TLC) with a team of teachers for humanities, math, and science. The teachers design a problem-solving activity for the students based on either local or state issues. Academics are taught in the morning classes. Each student is assigned to a special projects session which is the team activity for solving the problem for the TLC. This year, Kim's TLC is faced with the local issue on re-zoning for a British robotics plant. The team is presenting the results of their research to the town council.

The afternoon classes include language, music, athletics, and art. Each teacher teaches one elective and has one and one half hours for team planning. The school day ends at 3:30 after the entire TLC has an assembly update.

Typical school day in 1989:

6:00 a.m.
Kim boards the bus in front of his family's farm. As he leaves, his baby sister, Violet peers through the window pane wishing she could get on the big yellow bus.

6:30 a.m.
Kim arrives at school with his laptop computer in his backpack — anxious to print out his assignment from his floppies — and report to Multi-purpose Room I to meet with his TLC. Before the bell rings for the first TLC meeting, he must print out his homework, check the electronic bulletin board for his team's schedule for the day, and access the instructional assistance bulletin board for answers to his homework problems.

7:00 a.m.
150 students take their seats in Multi-purpose Room I and turn their attention to the classroom monitor for school announcement from the Principal, and introduction of the school and daily news.

7:15 a.m.
Students divide into their assigned TLC teams for math, science, and humanities instruction. They don't have to worry about grammar or composition teams since it is now integrated into the core curriculum. This frees the English teacher to incorporate language arts skills development into the core curriculum as an integral part of the instructional team.

In humanities today, Kim will be viewing a nationally renowned rural economist via the school's distance learning network. His team will probably struggle today over which question they will ask the specialist while he is on the air. Kim is glad that the computer download they received by satellite earlier has provided good statistical data that they have used in math class. This gave Kim a good background to support his project. He hopes his teammate in a neighboring state calls in today so he can say hi and discuss the articles that the students read.

The Scenarios

8:30 a.m.
Kim is getting worried about his test in the special projects session. He believes that he has mastered the techniques of getting the average of number and percents and is anxious to get to the computer terminal for some drill. After the drill, he will find time to seek help from the teacher on reading graphs which relate to rural population trends. Bobby knows that part of this special project session will include a test on math computation and graph analysis.

9:45 a.m.
Science class. Lab activities are enhanced by video laserdisc looking at the types of pollution created by electronic manufacturing.

11:00 a.m.
Test time. Thirty minutes — math computation. Through survey data, he is asked to compute the area of a plot of land proposed to be developed by the British firm as its plant site and to determine the tax revenue that would be generated from this parcel of land. In addition, he is asked to estimate loss that would result in a ten percent error in the measurement of the land.

Thirty minutes — team writing activity. Using information from the film and economists' presentation, he and his teammates used the word processor to update their recommendation in their persuasive letter to the town council.

12:00-12:30 p.m.
LUNCH. Kim looks at the digital board at the cafeteria—birthdays celebrated this month are on display — anyone I know? Today's special is Middle Eastern food. Kim looks forward to tasting some of the foods he has been reading about in the humanities segment of the rezoning project.

12:30-1:30 p.m.
Music. Kim can't get that tune that he and his teammates began composing on the computer yesterday out of his head. One of his teammates is missing today, and Kim wonders if he's really sick. He will call to let him know he's needed to help complete the composition. Kim is glad his music teacher does not require him to sing — the way his voice changes uncontrollably is really embarrassing!

1:30-2 p.m.
Free session in Multi-purpose Room. After making his absentee buddy call, Kim spends the remainder of this time in French dialogue lab.

2:00-3:00 p.m.
Kim is anxious to get to French class. Boy, is it getting exciting to have classmates all over the country and — oui, oui, — that Jessica from across the continent is cute! When their teacher shows her picture on the screen, Kim wishes she didn't live so far way. He thinks he will be taking a pop quiz today using his STAT controller, and hopes he can, for the first time, write dialogue with Jessica on the digitzer tablet. It will be two days before he has the chance again — tomorrow is sports.

3:00 p.m.
One more stop in the Multi-purpose Room before going home. Kim retrieves the results of his project presentation before he enters his questions for his TLC and makes his team's request for a community resource person.

We revisit Kim's town at the turn of the century. Since 1989, the town has seen a merging of cultures resulting from the influx of British residents.

There also has been a merging of industry and school cultures resulting in a longer school day. Students now arrive at different times and start their TLC block by mid-morning. Cultural activities and athletics compose the afternoon block and the extended day is industry and team project session. The TLC includes an industrial representative; the presence of this industry in the community has resulted in an influx of education-related technology.

Typical school day in the 21st Century:

8:00 a.m.
Violet grabs her textpak, which has replaced the laptop computer, as she leaves to catch the bus. She pauses momentarily as her brother's laptop on the shelf catches her eye — she wonders how he ever lugged it back and forth to school every day.

After pulling up her academic profile from her electronic locker last night, Violet was excited to see that she scored "excellent" on her math exercises. That means she could catch the late bus to school and would have time to follow her teacher's recommendation that she preview the next unit on square one videodisc in her textpak.

As Violet goes to her electronic locker and initiates a library search on robotics. She is joined by her teammates, Simon and Cecilia.

As in any typical middle school, they ignore the electronic announcements and review their team strategy for the day.

Day's Activities

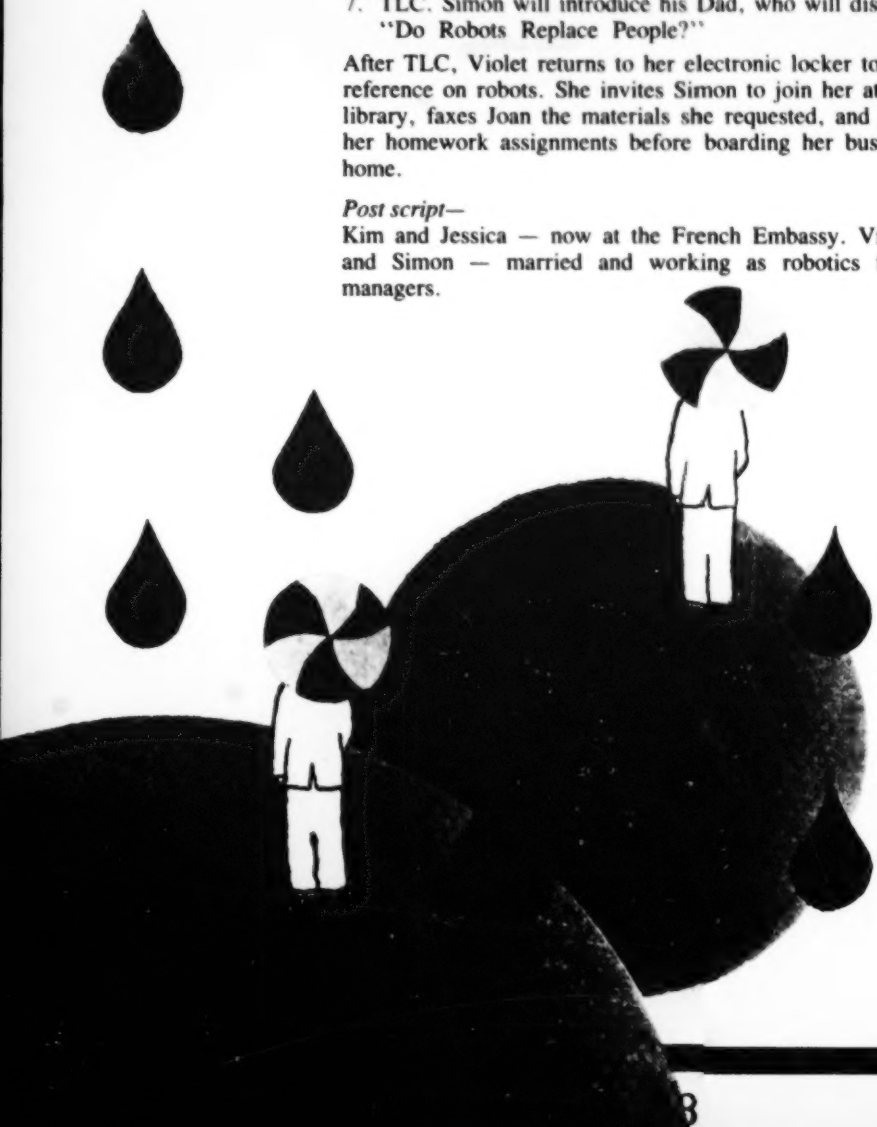
1. Call Joan and find out why she is really out of school.
2. Math class. Large screen projection, videodisc, review English/metric conversion and percents.
3. Humanities. Simon leads discussion on oriental culture, joined via satellite, by famous Korean author.

The Scenarios

4. Science. Continue on industrial robotics assignment. Violet has mixed emotions about this because of her Dad's concern expressed at breakfast over the impact of robotic technology on his job.
5. Clubs. Bi-lingual track of Japanese videodisc. Violet hopes that Simon will sit with her in the cafeteria today.
6. Athletics. Simon invites Violet to come along to the Go Club meeting.
7. TLC. Simon will introduce his Dad, who will discuss "Do Robots Replace People?"

After TLC, Violet returns to her electronic locker to get reference on robots. She invites Simon to join her at the library, faxes Joan the materials she requested, and gets her homework assignments before boarding her bus for home.

Post script—
Kim and Jessica — now at the French Embassy. Violet and Simon — married and working as robotics firm managers.



Urban/Suburban Middle School

1. Introduction

As the hologram of the President faded from view after his State of the Union address, Jane remembered the first time she was involved in acid rain research.

It was a cold morning in November 1995, when she ran out to the pond to collect the weekly sample of water. She got goose bumps realizing that she would be a part of the international gathering of data on the Acid Rain Project (ARP).

Her teacher put her sample of water into the Analyzer to prepare the data Jane would send to the Main Data Center. Two hundred countries sent in weekly data to build a worldwide data base, and scientists used this to measure the impact of acid rain on the environment to begin searching for solutions.

Jane remembered her conversations with Claude who was doing similar work in Copenhagen. Even though Jane spoke no Danish, and Claude did not speak English, the simultaneous translation capabilities of their electronic mail system helped them communicate easily. She especially remembered her crush on Claude when the Picture Phone first gave away his good looks!

She also remembered the complications of sending the data to the satellite dish. In 1995 she used her personal computer to calculate the satellite's distance to check if it was close enough to receive her message. "Kids today have it so easy," she thought. "Now they just push a button." Pushing a button transmits data to the nearest satellite which them relays it to the Main Data Center.

The President's address also reminded Jane that her older brother Jon was so excited about this data collection and analysis process that he used it as the basis for his current work at MIT. Because of his involvement with ARP in the early 1990's, John developed the primary technique used to neutralize acid rain. The President even mentioned him personally in her speech.

2. Teaching Process

After the President's address, Ms. Lally, one of the Spring Valley Middle School science teachers, began her class on the next phase of the ARP. A student in Senegal recently asked on the international mail system: "What is the relationship between global warming, ozone depletion, and acid rain?"

Several teachers proposed expanding ARP to explore

these ideas. The new project would be called "Thinking Globally, Acting Locally (TGAL)." Ms. Lally would spend the entire day with one hundred students whose Individualized Education Plans indicated that ARP/TGAL matched their learning goals. The project kick-off was a multi-media presentation on the current acid rain and ozone depletion situation around the world. Then she and Mr. Doven, the math teacher, would present some of the fundamental math and science concepts behind the project. Ms. Lally was especially excited about the quest presentation of Dr. Collins, who was currently working on these issues at one of the Space Stations.

In the afternoon session students would divide into groups for computer-based tutoring on the technology they would be using for this project.

Quickly, Ms. Lally walked to her computer station and typed herself a reminder to prepare for the teacher team meeting tomorrow. They would be discussing other subjects that could be integrated into this project by the English, Art, Social Studies and Foreign Language Departments. Ms. Powers' ideas on sending acid rain letters to legislators were great, but Mr. Nunes thought the students needed more preparation. He wanted the students to develop simulations of future social trends based on historical patterns.

3. Parent Meeting

Because the celebration of the ARP's success went beyond the teachers and students, parents were specially invited to a meeting that afternoon. Jane's father came early to the 4 p.m. meeting on ARP and its next phase in Spring Valley Middle School because he knew that parking would be crowded.

At the meeting Jane's teaching team described their role in the project and its next steps. Jane and her team captivated the audience for 20 minutes using a multimedia presentation the students prepared to explain the rationale for the research, the data collection and analysis techniques, and the work's results. Then a surprise video transmitted by their friends in the Soviet Union astonished the parents.

Clearly, this was much more than a science project. Jane's learning team was linked to 10,000 similar groups world-wide in a project which resulted in improvement of the quality of life for the current and future generations.

All the parents had become so interested in the project over the years that several were taking courses at the

local adult learning center as a result of their child's enthusiasm for learning.

4. Celebration

Later that night the entire community celebrated. Ms. Bennet, chair of the conservation committee and parent, was beaming with pride for the students.

"I am sure that I am speaking for the entire community when I say that we are proud that our school has been an important part of the international effort to stop acid rain. When we see our students working at Cedar Hill Pond and insisting that they stay up past their bedtime to build their models of pond ecology, we know that the excitement of helping the community and working with students from around the world prepares them to be active and responsible adult citizens. To the teachers of the Spring Valley Middle School, please accept the town's highest praise and gratitude. In appreciation, the business community and the parents association would like to donate this radiation probe to the school."

"And now Mr. Stanton from the Social Studies Department will introduce the next Think Globally, Act Locally Project, the Ozone Layer Health Check."

Mr. Stanton knew that the school had every right to be proud and honored by the town. The success of these projects had made it easier to introduce the Ozone Layer Health Check. This time the community would do more than politely applaud his presentation. This time the parents and town officials would believe that students made a difference in the local community and in the global community. It felt good to be a teacher.

The Scenarios

Rural High School

"Good morning, Maria," the computer whispered. "It is 7:00 a.m. and the temperature is 56 degress Fahrenheit. Your schedule for the day is....."

The day begins for Maria. Let's follow her through a typical school day.

She arrives at school at 8:00 a.m. and checks 'The Network," the schools' communication and scheduling center, to see if she is scheduled for a consultation with her teacher-facilitator, if her pen pal in Singapore left her a message, or if she is scheduled to link-up with the Robotics Lab at the University.

With her print-out in hand, she heads down the hall to

her first class. She is excited about her robotics project, which will be her major focus this semester. The teacher-facilitator meets her at the door.

"Maria, the motor for your project arrived yesterday. Do you know how to connect it?"

"No, I don't, but I have a teleconference with the University's Robotics Lab this afternoon. They are going to explain a few techniques to me."

"Have you checked the video discs in the library? I think they may have some information to help you."

The teacher then convenes the class, and Maria, along with the ten other students, watches a demonstration on electromagnetism. Maria realizes how this applies to her own project, and the ninety minutes fly by.

Her next class is English. The night before she read Capek's play "R.U.R.," the work in which the term robot was coined. It is only one of the sources he has been researching in her preliminary work analyzing the relationship between people and machines. After discussing her thoughts with her teacher, she walks down to the media center for her teleconference.

The media technician sends her to Terminal Four where the University is already on-line. Maria spends the next thirty minutes discussing motor applications with the robotics expert and some of his graduate assistants at the University. They explain that she must calculate the trigonometric functions of the arm joints before she can install the motor.

The conference ends with a tentative follow-up call scheduled for next week. Then Maria goes to her math class. Mr. Zoll is teaching the functions of sines and cosines today. After thirty minutes of taking notes and working sample problems on her laptop computer, Maria and her class have individual conferences with the teacher about their independent projects.

Keeping the trig formulas from her teleconference in mind, she thought about the arm angles giving her trouble. Tonight she would try putting the motors together.

It is now 12:30 p.m. and time for lunch. She grabs a cheeseburger and chats with her friends. Then, Maria drives her family's pick-up truck to the local hospital where she works two hours a day as a data entry clerk. She was placed there earlier in the school year as a result of a school-industry partnership.

As she drives home, she thinks about tomorrow's schedule. It will be a bit easier because she enjoys history, music, and art. Also, she doesn't have to be at

school until 9:00 a.m., which will give her time to exercise in the early morning.

When she gets home, she's ready for dinner. After watching a live rock concert on cable television, she decides to work on her paper with the computer checked out to her for the semester from the media center.

She dials the school library to check some references for her English paper. The database includes the library holdings of all the district schools and the public, university, and regional libraries. Maria finds a book she needs. Switching over to the interlibrary loan function, she checks the book out. The clerk at the library will ship it to her school in the morning.

She checks several other databases for more information and prints out a few items. Last, she checks her electronic mail before going to bed.

She was "chattering" with a friend when her mother came in and asked her not to tie up the lines all night.

Urban/Surburban High School

Diana's day begins with Introspection. This time is allotted for the student to center, meditate, reflect on past, current, or future activities, clear the mind, etc.

Diana then begins the knowledge portion of her day. She attends multi-disciplinary, integrated subject classes, where multiple subjects are taught based on a theme. This week, the students discovered several artifacts out on the research fields on the northwest section of the school grounds. They began an archaeological dig site and have uncovered several peculiar objects that have given them clues as to a civilization which existed here many years ago.

Diana's social sciences class is studying about past civilizations and cultures. Diana's class is using telecommunications to search data bases on topics and artifacts they have discovered. She has just sent a message through her laptop computer at her student workstation to a student in the foreign language class to help translate a script found scrawled on one of the objects. She then calls up the interactive videodisc surrogate field trip study of Cancun. She travels through the ruins, choosing many different paths. She selects in-depth information on digging techniques.

Diana's math class is working on designing the three dimensional computer graphics simulation of the dig site. They are working closely with the science class to determine the appropriate dating techniques to ascertain

the age of the artifacts. They also are studying the site's geological formations to incorporate the appropriate physical and chemical characteristics into the simulator, which will allow them to manipulate the environment. Diana spends some time with the expert system tutorial for the 3D simulation, which helps give her instruction and advice as she learns to use the technology. Diana finishes class by sending a picture of the dig site to Mario, who is at home with the flu. Mario has been keeping up with classwork through the curriculum database connection.

In her language arts class, Diana is preparing the newspaper reports of the class' recent activities and sending her draft story to the local newspaper, with hopes for its publication. Her classmates are also storyboarding the video story they are producing as a documentary, which her class will air on the Student Educational Television Network for a newspot. This afternoon her class is conducting an interactive videoconference, with other classes in the Soviet Union and in La Paz, Bolivia, to discuss their latest finds. Student have already interpreted the press release, and are completing the sequencing. Other classmates are putting finishing touches on the community newsletter which gets mailed to parents and community members. The deadline is only two hours away.

In her Arts and Music class, Diana is creating a composite painting of a fragment of a sculpture that was found. Only a few fragments of the sculpture were retrieved, so she is creating what she thinks would be the entire sculpture, with appropriate color patterns, according to the information she has researched (time dating determined in the Science class, and from the Education Data Infonet). One of her classmates is trying to reconstruct the sculpture in clay. In the Music section, students are composing original synthesized music expressing their emotions about the culture they are discovering. The digitized music will be overlaid on the video documentary being developed in the Language Arts class.

During lunch, Diana talks to one of her friends who is in one of the space science themes this week. During their morning classes, the students had downloaded pictures and data files of the Andromeda Galaxy, which had been taken by the Hubble Space Telescope and transmitted through NASA's Goddard Space Flight Center. This afternoon they would have a brief communication with scientists on the Space Station, who were

running a test on their acoustical experiment.

Following lunch, Diana attends the Thinking Skills class, in which special activities are designed to develop higher order thinking skills (creative problem solving, communications, etc.). Diana has been thinking about the fragile artifact that she broke while picking it out of the dig site. She has decided to design a hand tool which will dig around the edges of an object and support its structure. She is using a 3D simulator to test her machine on objects of different strengths, so that she can optimize her design. Her creativity and imagination are being enhanced by the technological tools she is using.

Diana is now in her Building class, in which she is constructing her machine. She is doing some preliminary tests on the machine in the miniature sandbox with a scale replica of the dig site. Diana will test her prototype machine out at the dig site this afternoon, to see how it performs in the actual environment. In this class, Diana takes her ideas and dreams, and builds them into reality.

Diana plays soccer in her Physical Education class, but forgot to turn in her nutrition paper. She will have to upload it to the class data folder tonight from her home. Thank goodness the laptop computer isn't heavy!

Diana finishes her day with another Introspection period, reflecting on the activities of the day and thinking about what she has learned in context of the entire theme.

The teachers meet to discuss the day's activities. Diana's social sciences teacher has reviewed her interactive videodisc experience of Cancun using the path tracking tool built into the program. The tracking path indicated that Diana would stay on the main path, and rarely chose alternate paths. The path tracker helped her teacher to decide that Diana should be set up with some risk-taking activities, and advises the other teachers of Diana's progress. Another teacher reports that a student came up with an exciting suggestion for further research. The teachers decide to modify tomorrow's activities to include the new research topic, which will allow them to teach the thinking skills from a different perspective. The teachers evaluate the students on practical experience which they demonstrate in the knowledge classes, as well as task performance and completion in the Thinking Skills and Building classes.

Diana's school serves students with diverse learning objectives. Dierdre is a Vietnamese girl who immigrated to the United States four years ago. English is her second language. She wants to earn a high school

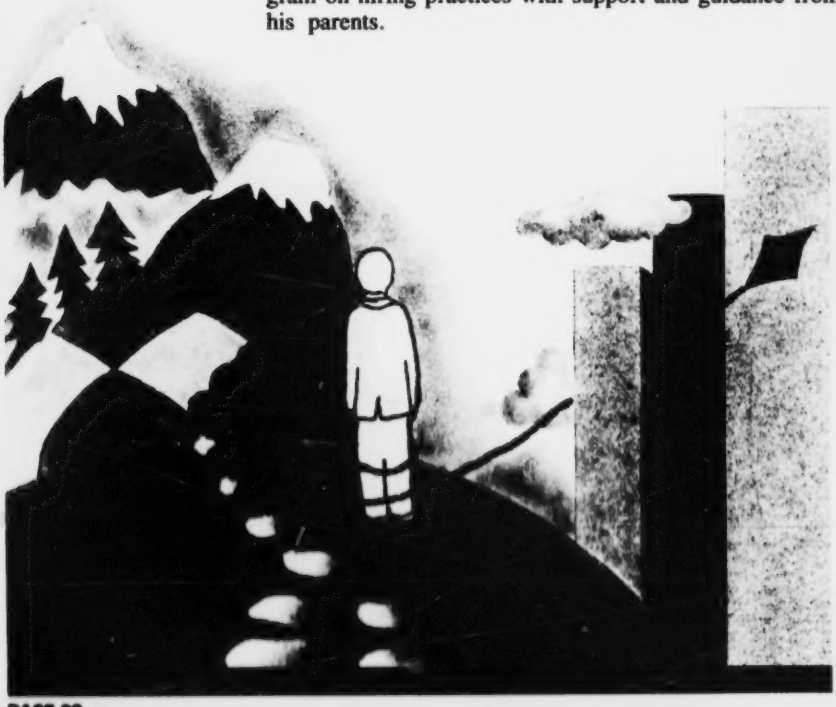
The Scenarios

diploma and become a chef in a fancy Vietnamese restaurant. Dierdre is highly motivated to learn, but, because her family is poor, her financial success is imperative.

Dierdre attends a special vocational center for immigrants which receives federal funds targeted for economic development, equity, and educational technology. She attends nutrition, physical education, visual arts, and business classes at the research-oriented high school. She also participates in a "learning-while-doing" apprenticeship at a local restaurant, which provides the income necessary for her to stay in school.

Gary is a Hispanic student who has limited English skills. He wants to pursue a career in business. Gary currently is home-bound due to medical disability, but academically is able to participate in school. The research-oriented school has provided Gary with a photo phone, fax modem, and computer. His house has cable TV to school and phone lines. He attends business, economics, and math classes via television and two-way radio. Class reading and assignments are faxed to him.

Gary coordinates a tele-marketing project in conjunction with student publications at the research-oriented school. He also conducts an "independent study" program on hiring practices with support and guidance from his parents.



The Challenge

The potential of existing and emerging technologies for education is great, but it must be understood and integrated into education in a systematic, cohesive manner. Changing education will not, and should not, occur overnight. NFIE believes it requires a concerted effort by all sectors of society to decide how best to use technology as an agent for that change.

In planning for the future, we must follow the lead of innovative teachers and other change agents who today are trying new tools and breaking out of traditional constraints to improve teaching and learning.

These scenarios offer some options for learning tomorrow. There may be, and most likely are, many more. It is imperative that we create a vision and work toward it to make future schools meet the needs of students. Scenario-builders need not be technology experts to vision for the future. All they require is the opportunity to dream and the courage to move forward.

Developing New Pictures

The visioning process needs to continue at all levels. These six scenarios are just a start. Communities must define their own values and goals for education, keeping in mind that technology may play a part in realizing their aspirations.

As our world grows increasingly complex, we find ourselves specializing to the point where we can't understand what others do and why. When diverse perspectives meet, the ill-conceived turf issues and finger-pointing that often surround discussions of educational reform disappear. The participants often are started to realize they are not really fighting each other. They all seek the same things, but have felt powerless to attain them. Through sharing experiences and clarifying values and goals, participants can better understand the root of the problem as well as possible solutions.

The process through which these Images of Potential were drawn can be replicated at the state, local, and even school building level. NFIE has facilitated several such processes at various levels and has found that successful scenario building or visioning involves several key components:

- bring together people with diverse backgrounds, roles, and responsibilities to discuss a common goal or set of concerns. At the school building level, for example, the group may consist of teachers, students, administrators, parents, corporate and community representatives, a politician, etc.
- find an isolated place protected from outside interruptions where the group can focus on the task.
- take time to get acquainted and discover what resources each participant brings to the process. Discuss literature you've read, teaching and learning experiences, the nature of your work, etc.
- spend some time thinking about the constituency group. Who are the students? What are their needs? What other issues and pressures impact them, e.g. social, economic, and political.
- remove constraints. Strategic planners often are inclined to focus on what can be done starting today. This approach stifles creativity because we get caught in the parameters of why we can't do something, due to bureaucracy, finances, etc. Instead, the group

might try "visioning" the perfect situation without any of the current constraints. Decide first where it is you would like to go, then draw the map to get there.

- once you have created the vision, take time to consider what you can and cannot change. In the case of education, we know we can't change the American family structures and trends, nor the economy, but we can work with how schools are structured, how other units affect the school, or how teacher education will affect the future. Think about what will make the scenario real. Recognize external constraints, but only after you have defined the internal goals.
- play with how things work. Don't insist on a linear progression. Strategic plans tend to begin in fits and starts. One technique used well is the story board. Participants brainstorm different episodes they would like to see occur. You can build the bridges between the episodes later. Don't try to write sentence by sentence or get too bogged down in details. The group can spend a day drafting an eloquent introduction, leaving little time to construct the meat of the scenario.
- most importantly, have fun. Make a serious attempt, however, to be open-minded and creative. Stretch, probe, and draft and then stretch some more. Building scenarios may be more work than you think, but it probably will be more gratifying as well.

Appendix

Glossary

Camcorder
Combination of *cam*era and re*corder*. Contains the video camera and recorder all in one unit.

Compact disc
Generally refers to the five-inch discs (CD-ROM) that are read by laser beam, and are not touched by a magnetic head, as most hard disk drives are. Most people are familiar with the audio CD discs which are digitally recorded playing back very clear sound. The five-inch disc is also used in CD-ROM drives for computers, and can hold a great deal of information.

Computer synthetic voice translation
Refers to the technology of taking text, and converting it into artificial speech using a computer. Also known as voice synthesis.

Desktop publishing

The capability of using microcomputers and laser printers to produce publish-quality materials. This is an extremely efficient way to produce documents for publication, since it is very inexpensive compared to typesetting and work can be completed in a fraction of the time.

Electronic mail

Sending and receiving messages via computer over telephone lines. Usually seen in the information and bulletin board systems, where one person composes a message at this computer, sends it to the bulletin board system where the message is posted, and read by anyone else connected to the system.

Fax machine

From "facsimile." This machine scans a document (text or graphics), converts the document (digitizing) into code, and sends it through the telephone line to another machine at another location. The receiving fax machine decodes the digitized message and converts it back to the original document.

Fiber optics

A bundle of many glass fibers that transports light across the length of the fibers. Messages, phone conversations can be carried through these fibers. The fibers can also be bent or turned, allowing someone to view an object which was otherwise inaccessible.

Hardware

The physical components of a computer system, such as the computer itself (microprocessor), printer, monitor, videodisc player, etc.

Hologram

A thin, flat piece of glass or film through which can be viewed a 3-dimensional object. The true 3-D hologram actually allows viewer to see around different parts of an image by moving his or her head up and down, or side to side.

Multimedia

The use of more than one technology to develop a presentation, educational lessor, or production. Possible combinations include a computer with certain software such as animation, videodisc player, CD-ROM player, synthesizer, etc.

Interactive videodisc
A combination program using a computer and videodisc player, which allows the user to interact with the events occurring on the screen. The user can stop the video, search for other information or pictures, and generally create his or her own path through the material.

LCD panel
A liquid crystal display used in many watches and computer panels. The display is usually made up of 7 segments in the form of a figure 8. With this display, any number or letter can be generated, although some letters will be in upper case, and some in the lower case.

Laserdisc or videodisc
The large 12 inch discs which are read by laser on a videodisc player. Each side of these large discs may hold 54,000 frames of information. This may include still pictures, text, graphics, or full motion video or "movie" segments.

Microwave
Extremely high frequency wavelength, which is what the major television networks use to transmit their programs. The transmissions are broadcast to satellites which amplify and retransmit the signal to many other locations, which receive with their own satellite dishes. Cellular phones, and all radar equipment use microwaves.

Appendix

Modem
A "computer telephone" which converts information generated on a computer into tones that can be transmitted over telephone lines. The tones are changed in pitch, or "modulated" to represent the information.

Overhead projection
A device which allows user to show a transparency up on a movie or film screen.

Robotics
The technology related to machines which can be programmed to do more than one task or activity over and over again, yet can be reprogrammed to do other tasks. Robots can be made to manipulate and move materials, tools, or special devices. Some current applications include welding, and even building computers.

Scanner

A machine which can read and "see" the dark and light images of a document (text or graphics), and convert them into digitized information which can be seen and used on a computer. One can "scan" a picture of a student, then see the picture in digitized format on the computer screen. The picture can then be manipulated by using computer graphics applications.

Software

Programs which are written for computers which allow you to perform tasks, such as word processing, graphics, spreadsheets, databases, etc.

VCR

Video Cassette Recorder. Allows user to play videotapes (i.e. movies) on a television screen. Also allows user to record a program that is playing on the TV onto a videotape cassette, to playback at a later time.

Voice recognition unit

A device which is programmed to recognize certain words that are spoken by a person, and can act on those words. At this time, these devices are in the development stage, and can understand a limited vocabulary from usually one person. The user might say "Print the memo," and the device will pass the print command to the computer which will print out specified document.

Acknowledgements

NFIE acknowledges with gratitude the following professionals for their invaluable contribution to these Images of Potential:

The Hitachi Foundation for stimulating the use of advanced technologies in reforming the education of our youth.

The Johnson Foundation for fostering efforts to provide children with equal access to educational tools and opportunities.

The NFIE Board of Directors for its vision and leadership in restructuring schools, and for recognizing the importance of technology in meeting the nation's educational goals.

The planning group for its guidance in identifying essen-

tial issues and nationally-recognized leadership in technology and future studies — Cheryl Kane (*Chair*), Susan Barto, Karen Bunting, Denise Cavanaugh, Chris Dede, Gloria Frazier, James Mecklenburger, Gail Morse, Alan November, David Wallace.

The builders of the Rural Elementary School scenario for their vision of life-long learning and teaching, community support groups, and for challenging us to focus on the risk-takers rather than the naysayers — Judith Armstrong, Gloria Frazier, Peggy Lathlaen, Adrienne Moreland, and Frank Withrow.

The builders of the Urban/Suburban Elementary School scenario for fun-filled bus rides, higher-order feeling, and smart homes and communities — Lyn Chan, Franklin Hill, Jeff Holte, Henry Ingle, Steve Ober.

The builders of the Rural Middle School scenario for a rare bit of technology, adolescent romance, and economic development as it impacts education — Harvey Long, Gail Morse, Patsy Tinsley, and David Wallace.

The builders of the Urban/Suburban Middle School scenario for presidential holograms, reflections on financing, and survival skills for visioning — Les Litherland, Alan November, Kenneth Rossano, and Sue Talley.

The builders of the Rural High School scenario for restrained melodrama, school-industry partnerships, and insightful distance learning — Elvira Crocker, Aprill Hastings, Paul Starjack, Walt Tremer, and Lawrence Wiget.

The builders of the Urban/Suburban High School scenario for story boards, six ounce laptops, time for student introspection, and a collage of learning styles — Karen Bunting, Sylvia Charp, Chris Dede, Ron Fortunato, and Bill Hudson.

Denise Kavanaugh for designing and facilitating the scenario-building process and keeping the authors "on task."

Chris Dede for direction and practical strategies for effective scenario development.

Ron Fortunato for a user-friendly glossary of technological terms used in the scenarios.

Paine Bluett Paine, Inc. for visually representing the voices of the scenario-builders in this publication.

Appendix

NEA Communications for their assistance in the design and production of this publication.

The NFIE staff for administrative and logistical support of conference activities and for writing and editing this publication — Susan Barto, Julie Devaud, Cheryl Kane, Karen Keith, Harry Mitchell, Melody Reynolds, Karilyn Smith, and James Wilson.

Donna C. Rhodes

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Executive Director

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DONNA C. RHODES
Executive Director

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NATIONAL
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1201 16th Street, NW
Washington, DC 20036

(202)822-7840